MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1 , 2015/2016

ERT3026 - AUTOMATION
(RE)

12 OCTOBER 2015
9:00 a.m – 11:00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question paper consists of **5 pages** including cover page with **5 Questions** only.

2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

A simple load cell, as shown in **Figure Q1 (a)**, consists of an aluminum post of 0.025 m radius with a detector and compensation strain gages.
The 140 Ω strain gauges are used in the bridge of **Figure Q1(b)** with $V = 4V$, $R_1 = R_2 = R_D = 140\ \Omega$, *Gage Factor = 2.13* and modules of elasticity for aluminum = 6.89×10^{10} N/m^2.
Determine:

(a) The change of resistance, ΔR **[12 marks]**

(b) Resistance with post under compression **[2 marks]**

(c) Variation of bridge offset, ΔV, for load of 0 to 22240 N. **[6 marks]**

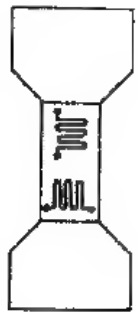

Figure Q1(a)

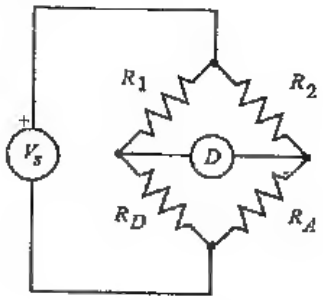

Figure Q1(b)

Question 2

(a) A double acting hydraulic cylinder is to be used to move a work piece in a manufacturing operation. The relief valve setting is 70×10^5 N.
The piston area is 0.016 m^2 and the rod area is 0.0045 m^2. If the pump flow is 0.0013m^3/ s, find the cylinder speed and load- carrying capacity for the

(i) Extending stroke. **[6 marks]**

(ii) Retracting stroke. **[6 marks]**

(b) A DC servomotor is directly coupled to a blower shaft for an industrial process with the 24V supply voltage. The motor has a torque constant of 0.09 N-m/A. A voltage constant is 0.12V/(rad/sec) and the armature resistance is 1.9 Ω. Determine:

(i) the stall torque of the motor **[4 marks]**

(ii) the maximum speed at a torque of zero **[4 marks]**

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Question 3

(a) Write a programmable logic controller (PLC) ladder diagram to control forward and reverse running of the motor as shown in the **Figure Q3(a)** by using the Input/Output assignment as shown in **Table Q3(a)**

This is possible by using two switches forward switch (X0) and reverse switch (X1) and the operation condition as follows:

- The forward switch is pressed,
- After 1 second, contactor Y0 will be enable and the motor run forward.
- The reverse switch is pressed,
- After 2 second, contactor Y1 will be enable and the motor run reverse.
- Y0 and Y1 will be disabling and the motor will stop running.

[15 marks]

Table Q3-(a) The Input/Output Assignment for Question 3(a)

Input Address	**Input Devices**
0.00	Push Button Switch (X0)
0.01	Push Button Switch (X1)
0.02	Push Button Switch (X2)
T0000	Timer One (1 sec)
T0001	Timer Two (2 sec)
Output Address	**Output Devices**
2.00	Forward Running(Y0)
2.01	Reverse Running(Y1)

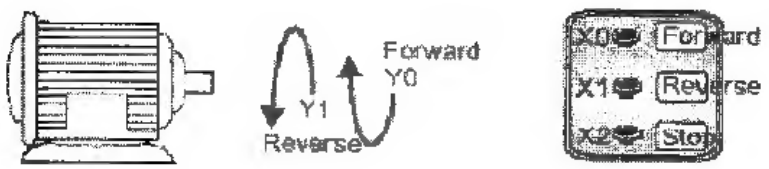

Figure Q3.(a): Motor for Question 3(a)

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Question 3

(b) Analyze the system operation of the PLC ladder diagram as shown in the **Figure Q3 (b).** **[5 marks]**

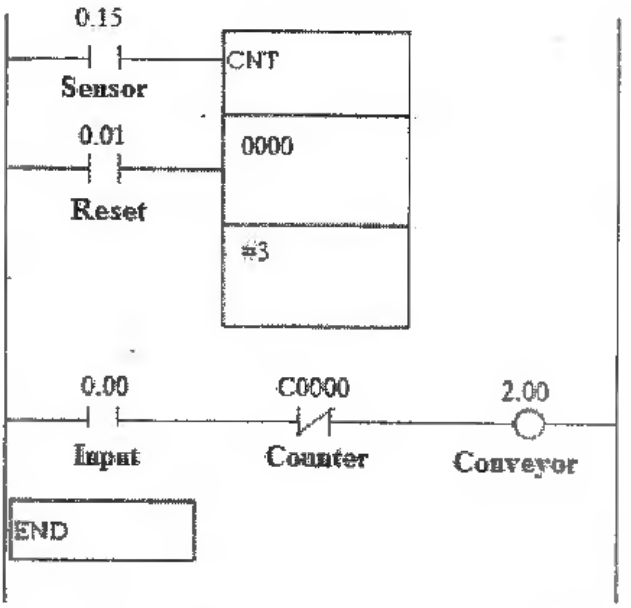

Figure Q3 (b) PLC Ladder Diagram for Question 3(b)

Question 4

A 20-stations in-line transfer machine has an ideal cycle time of 0.4 min. Station breakdowns occur with a probability p = 0.01. Assume those station breakdowns are the only reason for line stops. Average downtime = 0.7 min per line stop. Use the upper-bound approach to determine the following:

(i) Ideal production rate **[3 marks]**

(ii) Frequency of line stops **[3 marks]**

(iii) Average actual production rate **[8 marks]**

(iv) Proportion down time **[3 marks]**

(v) Line efficiency **[3 marks]**

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Question 5

A flexible machining system (FMS) is being planned that will consist of four workstations and a part handling system. Station 1 will be a load/unload station. Station 2 will consist of horizontal machining centers. Station 3 will consist of vertical machining centers. Station 4 will be an inspection station.

For the part mix that will be processed by the FMS, the workloads at the four stations are as follows:

WL_1 = 8.0 min, WL_2 = 23.0 min, WL_3 = 17.0 min, and WL_4 = 10.5 min. The workload of the part handling system WL_5 = 9.0 min.

The FMS will be operated 16 hours per day, 250 days per year. Maintenance will be performed during nonproduction hours, so uptime proportion (availability) is expected to be 97%. Annual production of the system will be 50,000 parts.

Determine:

(a) The production rate. **[4marks]**

(b) The number of machines (servers) of each type (station) required to satisfy production requirements. **[6 marks]**

(c) The utilizations of each station in the system for the specified production requirements. **[6 marks]**

(d) What is the maximum possible production rate of the system if the bottleneck station were to operate at 100% utilization? **[4 marks]**

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